ECONOMIC GEOLOGY

AND THE

BULLETIN OF THE SOCIETY OF ECONOMIC GEOLOGISTS

EDITOR: BRIAN J. SKINNER
Yale University, New Haven, Connecticut 06520

BUSINESS EDITOR: KENNETH F. CLARK
University of Texas-El Paso, El Paso, Texas 79968
(915) 533-1965

EDITORIAL BOARD

Through 1983

MARCO T. EINAUDI, *Stanford, California*
GARY P. LANDIS, *Denver, Colorado*
ARTHUR W. ROSE, *University Park, Pennsylvania*

Through 1984

GERHARD VON GRUENEWALDT, *Pretoria, Republic of South Africa*
JEFFREY S. HANOR, *Baton Rouge, Louisiana*
ROBERT E. ZARTMAN, *Denver, Colorado*

Through 1985

DAVID A. CRERAR, *Princeton, New Jersey*
STEPHEN E. KESLER, *Ann Arbor, Michigan*
DANNY M. RYE, *New Haven, Connecticut*
NEIL WILLIAMS, *Brisbane, Australia*

Through 1986

ALEX C. BROWN, *Montreal, Canada*
WILLIAM F. CANNON, *Reston, Virginia*
J. THOMAS NASH, *Denver, Colorado*

Through 1987

J. MURRAY DUKE, *Ottawa, Canada*
DAVID I. GROVES, *Nedlands, Western Australia*
FRANK G. LESURE, *Reston, Virginia*
DAVID I. NORMAN, *Socorro, New Mexico*

MANAGING EDITOR:
NANCY A. AHLSTROM

EDITORIAL ASSISTANTS:
MABEL PETERSON
CATHARINE D. WILDER

VOLUME 78

NEW HAVEN, CONNECTICUT

THE ECONOMIC GEOLOGY PUBLISHING COMPANY

1983

SOCIETY OF ECONOMIC GEOLOGISTS

THE PUBLICATIONS OF WHICH CONSTITUTE A PART OF THIS JOURNAL

OFFICERS FOR 1983

RICHARD W. HUTCHINSON, *President*
230 Hunt Club Drive
London, Ontario N6H 3Z1, Canada

VICTOR F. HOLLISTER, *Vice-President*
6071 Madrona Crescent
Richmond, B. C. V7C 2T3, Canada

WILLIAM C. KELLY, *President-Elect*

G. A. BARBER, *Vice-President-Elect*

JOHN M. GUILBERT, *Vice-President for Regional Affairs*

RALPH W. MARSDEN, *Treasurer*
Department of Geology
University of Minnesota—Duluth
Duluth, Minnesota 55812

ARNOLD L. BROKAW, *Secretary*
185 Estes Street
Lakewood, Colorado 80226

MAURICE A. CHAFFEE, *Membership Secretary*
U.S. Geological Survey
P.O. Box 25046, Mail Stop 973
Federal Center
Denver, Colorado 80225

Regional Vice-Presidents

MORRIS VILJOEN, Africa
SHUNSO ISHIHARA, Asia
MICHAEL SOLOMON, Australia
FRANK M. VOKES, Europe
GUILLERMO SALAS, North America
JOZEF AMBRUS, W., South America

Councilors

1981–83

HUBERT L. BARNES
JOHN P. HUNT
ROBERT W. BOYLE

1982–84

JOHN E. FROST
PETER L. SIEMS
JACK A. SIMON

1983–85

SAMUEL S. ADAMS
DANIEL R. SHAWE
STEVEN D. SCOTT

DONALD E. WHITE,
Past President

ANTHONY J. NALDRETT,
Past Vice-President

Société de Géologie Appliquée aux Gîtes Minéraux

G. FRIEDRICH, *Acting President*
F. SAUPÉ, *Secretary*

Economic Geology Publishing Company

PAUL K. SIMS, *President*
BRIAN J. SKINNER, *Editor*
KENNETH CLARK, *Business Editor*

COMMITTEES

Executive Committee

RICHARD W. HUTCHINSON, *Chairman*
ARNOLD L. BROKAW
JOHN M. GUILBERT
VICTOR F. HOLLISTER
WILLIAM C. KELLY
RALPH W. MARSDEN
PAUL K. SIMS
DONALD E. WHITE

Admissions Committee

DAVID A. LINDSEY, 1981–83, *Chairman*
ARTHUR E. SOREGAROLI, 1981–83
ALBERTO TERRONES, 1982–84
FREDERICK M. BECK, 1983–85
EUGENE V. CIANCANELLI, 1983–85
F. J. HUMPHREY, 1983–85

Committee on Committees

ROBERT HODDER, 1982, *Chairman*
JOHN E. FROST
J. JULIAN HEMLEY
STEPHEN KESLER, 1983, *Chairman*
PATRICK MUFFLER
ROBERT G. BLAIR

Committee on Information on Mineral Problems

PAUL EIMON, 1983–85, *Chairman*
ALLEN V. HEYL, 1981–83
ROBERT H. STEBBINS, 1981–83
MAURICE CHAFFEE, 1982–84
ROBERT E. WALLACE, 1982–84
W. D. B. WINFIELD, 1983–85

Finance Committee

RICHARD D. ELLETT, 1983, *Chairman*
ROBERT S. MOEHLMAN, 1980–82
SIEGFRIED MUESSIG, 1981–83
WALTER E. SEIBERT, JR., 1981–83
WESTON BOURRET, 1982–84
RALPH W. MARSDEN (ex-officio)

International Lecturer Committee

EDWIN TOOKER, 1983–84, *Chairman*
DONALD DAVIDSON, 1982–83, *Secretary*
ALAN GOODWIN, 1983
WAYNE BURNHAM, 1983–84
MARCO EINAUDI, 1983–85
JOHN E. FROST, 1983–85

Lindgren Award Committee

GERALD K. CZAMANSKE,
1981–83, *Chairman*
CHARLES MEYER, 1981–83
ROBIN BRETT, 1982–84
R. W. HODDER, 1982–84
JAMES CRAIG, 1983–85
R. L. STANTON, 1983–85

Nominating Committee

JOHN E. FROST, 1983, *Chairman*
J. KALLIOKOSKI
D. F. SANGSTER

Penrose Medal Committee

WAYNE HALL, 1982–84, *Chairman*
JOHN W. ANTHONY, 1981–83
T. A. NETELBEEK, 1981–83
G. A. BARBER, 1982–84
PHILIP GUILD, 1983–85
RODNEY V. KIRKHAM, 1983–85

Program Chairmen:

GUNNAR KULLERUD, Fall 1983
JOHN ALBERS, Winter 1984
JOHN SCHILLING, Fall 1984
FREDERICK GRAYBEAL, Winter 1985
ULRICH PETERSEN, Fall 1985

Program Policy Committee

ANTHONY J. NALDRETT, *Chairman*
FINLEY CAMPBELL, 1981–83
ARTHUR E. SOREGAROLI, 1982–84
VICTOR F. HOLLISTER
G. A. BARBER
ARNOLD L. BROKAW (ex-officio)
ERIC CHENEY (ex-officio)
LEWIS B. GUSTAFSON (ex-officio)

Publications Committee

ERIC S. CHENEY, 1981–83, *Chairman*
KEITH PAPKE, 1981–83
DONALD F. SANGSTER, 1982–84
PAUL LINDBERG, 1982–84
A. L. LAMARRE, 1983–85
JOHN F. SLACK, 1983–85

Research Committee

LEWIS B. GUSTAFSON, 1982–84, *Chairman*
GEORGE BRIMHALL, 1981–83
RICHARD DARLING, 1981–83
GEORGE A. DESBOROUGH, 1981–83
SAMUEL S. ADAMS, 1982–84
STEVEN D. SCOTT, 1982–84
BRUCE R. LIPIN, 1983–85
G. E. MCKELVEY, 1983–85
GERHARD WESTRA, 1983–85

Short Course Committee

WILLIAM C. KELLY, 1983, *Chairman*
ARTHUR SOREGAROLI, 1983
PHILLIP BETHKE, 1983–84
ANTHONY NALDRETT, 1983–84
ERIC S. CHENEY, 1983–85
PAUL EIMON, 1983–85

Society of Economic Geologists Medal Committee

A. DARRYL DRUMMOND, 1982–84, *Chairman*
WILLIAM C. KELLY, 1981–83
PAUL K. THEOBALD, JR., 1981–83
OGDEN TWETO, 1982–84
WILLIAM F. CANNON, 1983–85
R. H. MCMILLAN, 1983–85

Thayer Lindsley Visiting Lecturer Committee

PETER R. BUSECK, 1981–83, *Chairman*
TED G. THEODORE, 1981–83
ALAN M. GOODWIN, 1982–84
DANIEL R. SHAWE, 1982–84
DAVID L. GILES, 1983–85
PRIESTLEY TOULMIN III, 1983–85
CLAY T. SMITH, *Secretary*
Geology Department
New Mexico Institute of Mining and Technology
Socorro, New Mexico 87801

CONTENTS OF VOLUME 78

Number 1

Organic Geochemistry of the Pine Point Lead-Zinc Ore Field and Region, Northwest Territories, Canada ..... *R. W. Macqueen and T. G. Powell* 1

Post-Kombolgie Metasomatism at Jabiluka, Northern Territory, Australia, and Its Significance in the Formation of High-Grade Uranium Mineralization in Lower Proterozoic Rocks ..... *Lewis B. Gustafson and Laurence W. Curtis* 26

Mineralogy and Geochemistry of Epigenetic Features in Metalliferous Sediment, Atlantis II Deep, Red Sea ..... *R. A. Zierenberg and W. C. Shanks III* 57

Origin and Ore-Forming Consequences of the Advanced Argillic Alteration Process in Hypogene Environments by Magmatic Gas Contamination of Meteoric Fluids ..... *George H Brimhall, Jr., and Mark S. Ghiorso* 73

Deformation Fabrics in Barite and Fluorite of the Del Rio District: Their Implications for the Relative Timing of Mineralization and Deformation ..... *David J. Tieman and Otto C. Kopp* 91

Iron Disulfide Minerals and the Genesis of Roll-Type Uranium Deposits ..... *Richard L. Reynolds and Martin B. Goldhaber* 105

Uranium Geochemistry and Fission-Track Mapping of Phosphorites, Zefa Field, Israel ..... *Y. Avital, A. Starinsky, and Y. Kolodny* 121

Molybdenum and Other Heavy Metals of the Mecca Quarry and Logan Quarry Shales ..... *Raymond M. Coveney, Jr., and Sharon P. Martin* 132

Genetic Implications of Halide Enrichment near a Mississippi Valley-Type Ore Deposit ..... *Samuel V. Panno, Garman Harbottle, Edward V. Sayre, and William C. Hood* 150

Scientific Communications

Geologic, Sulfur Isotopic, and Fluid Inclusion Study of the Ssang Jeon Tungsten Mine, Republic of Korea ..... *Chil-Sup So, Kevin L. Shelton, and Danny M. Rye* 157

Adaptation of SGE-USGS Heating-Freezing Stage for Operation Down to −196°C ..... *Jill Dill Pasteris* 164

Strontium Isotope Geochemistry of the Santa Rita Porphyry Copper Deposit, New Mexico ..... *Richard P. Taylor and Brian J. Fryer* 170

Correlations between the Chemical and the Geologic Origins of Anthraxolite from the Gunflint Formation, Thunder Bay, Ontario ..... *Ryochi Hayatsu, Randall E. Winans, David S. Newman, Joseph J. Mancuso, and Ronald E. Seavoy* 175

Discussions

Apatite Crystallite Size of Precambrian Phosphorites of India—A Discussion ..... *Duncan McConnell* 181

Apatite Crystallite Size of Precambrian Phosphorites of India—A Reply ..... *Neeta Srivastava and D. M. Banerjee* 181

Reviews

Advances in Geology of the Porphyry Copper Deposits, Southwestern North America (S. R. Titley, ed.) ..... *Richard H. Sillitoe* 183

Exploration Geochemistry Bibliography. Special Volume II (H. E. Hawkes, chm., bibliography comm.) ..... *Arthur W. Rose* 183

Physical Principles of Exploration Methods (A. E. Beck) ..... *Michael L. Oristaglio* 184

Methods in Field Geology (Frank Moseley) ..... *Harry J. Bradbury* 184

Our Modern Stone Age (Robert L. Bates and Julia A. Jackson) ..... *R. V. Dietrich* 185

Metamorphic Tectonites of the Himalaya (P. S. Saklani, ed.) ..... *Gordon S. Lister* 185

Analysis of Fluvial Depositional Systems (Andrew D. Miall) ..... *W. E. L. Minter* 186

Archaean Geology: Second International Symposium, Perth 1980 (J. E. Glover and D. I. Groves, eds.) ..... *Maarten J. de Wit* 187

Books Received ..... *Brendan Caulfield, Paul Merewether, and Kevin Shelton* 187

Interesting Papers in Other Journals 190

Erratum 200

Number 2

Sulfur Isotope Data and the Nature of the Hydrothermal Systems at the Panguna and Frieda Porphyry Copper Deposits, Papua New Guinea ..... *C. J. Eastoe* 201
The Coxco Deposit—A Proterozoic Mississippi Valley-Type Deposit in the McArthur River District, Northern Territory, Australia ..... *R. N. Walker, B. Gulson, and J. Smith* 214
Geochemical Constraints on the Genesis of Copper Mineralization in the Mount Gunson Area, South Australia ..... *Janice Knutson, T. H. Donnelly, and D. G. Tonkin* 250
The Anderson Mine (Arizona)—An Early Diagenetic Uranium Deposit in Miocene Lake Sediments ..... *Andreas Mueller and Peter Halbach* 275
Distribution of Aluminum-Rich and Chromium-Rich Chromite Pods in Ophiolite Peridotites ..... *Marc Leblanc and Jean-François Violette* 293
High Silver Content of Fluid Inclusions in Quartz from Guadalcazar Granite, San Luis Potosi, Mexico: A Contribution to Ore-Genesis Theory ..... *Stephen Chryssoulis and Neil Wilkinson* 302
Calculation of Available Alumina in Bauxite during Reconnaissance Exploration ..... *J. H. Bredell* 319

Scientific Communications

A Sulfur Isotopic and Fluid Inclusion Study of the Cu-W-Bearing Tourmaline Breccia Pipe, Ilkwang Mine, Republic of Korea ..... *Chil-Sup So and Kevin L. Shelton* 326
Evaluation of Soil Anomalies by Discriminant Analysis in Geochemical Exploration for Carbonate-Hosted Lead-Zinc Deposits ..... *Dragan Brabec* 333
Age of Sulfide Ores in the West Shasta and East Shasta Districts, Klamath Mountains, California ..... *Rodney Watkins and Howard L. Stensrud* 340
A Bauxitic Paleosol in Phosphate-Bearing Strata of Northern Pakistan ..... *M. I. Ghaznavi, T. Karim, and J. B. Maynard* 344
Enargite-Bearing Massive Sulfide Deposits High in Porphyry Copper Systems ..... *Richard H. Sillitoe* 348
Distribution and Mobility of Uranium and Thorium in the Peralkaline Soldier Meadow Tuff, Northwestern Nevada ..... *Edmond J. Stuart, Theodore J. Bornhorst, William I. Rose, Jr., and Donald C. Noble* 353

Reviews

Dynamics of Passive Margins. Geodynamics Series Volume 6 (R. A. Scrutton, ed.) ..... *Christine Powell* 359
Sedimentology: Process and Product (M. R. Leeder) ..... *Charles H. Summerson* 359
Sedimentary Petrology (Harvey Blatt) ..... *Gene L. La Berge* 361
Un Minéral Traceur pour la Prospection Alluvionnaire: L'ilmenite. Relations entre Ilmenites Magnesiennes, Basaltes Alcalins, Kimberlites et Diamants. Documents du B.R.G.M. No. 37-1982 ..... *François J. Lampietti* 361
Books Received ..... *Brendan Caulfield, Paul Merewether, and Kevin Shelton* 362
Interesting Papers in Other Journals 364
Reviewers of Manuscripts 372
IMA Commission on Ore Microscopy 374
Society of Economic Geologists 376

Number 3

Composition and Origin of Ore-Forming Fluids in a Carbonate-Hosted Porphyry Copper and Skarn Deposit: A Fluid Inclusion and Stable Isotope Study of Mines Gaspé, Quebec ..... *Kevin L. Shelton* 387
The Direct Derivation of Sillimanite from a Kaolinitic Precursor: Evidence from the Geco Mine, Manitouwadge, Ontario ..... *R. L. Stanton* 422
Geochemical and Stable Isotope Studies of the No. 4 Lode, Kalgoorlie, Western Australia ..... *Suzanne D. Golding and Allan F. Wilson* 438

Source of Mineralizing Components in Hydrothermal Ore Fluids as Evidenced by $^{87}Sr/^{86}Sr$ and Stable Isotope Data from the Pasto Bueno Deposit, Peru ..... *D. I. Norman and G. P. Landis* 451
Seawater-Basalt Reaction and the Origin of Greenstones and Related Ore Deposits ..... *Mark H. Reed* 466
Expandable Layer Silicates Associated with the Hydrothermal Talc Deposits of Murphy, North Carolina ..... *A. M. Blount, Douglas Williams, Janice Jenkins, and Ben Warner* 486

Scientific Communications

Age of Uranium Mineralization at the Highland Mine, Powder River Basin, Wyoming, as Indicated by U-Pb Isotope Analyses ..... *Elmer S. Santos and Kenneth R. Ludwig* 498
Time of Formation of Soft Iron Ore on the Gunflint and Mesabi Ranges (Ontario, Canada and Minnesota, U. S. A.) ..... *Michael Purucker* 502
Nuggihalli Schist Belt in the Karnataka Craton: An Archean Layered Complex as Interpreted from Chromite Distribution ..... *Revanna Nijagunappa and Channappa Naganna* 507
Occurrence and Age of Tin Mineralization in the Cordillera Oriental, Southern Peru ..... *Alan H. Clark, Vicente V. Palma, Douglas A. Archibald, Edward Farrar, Mario J. Arenas F., and Ronald C. R. Robertson* 514
Mineralogic and Fluid Inclusion Studies of the Washington Cu-Mo-W-bearing Breccia Pipe, Sonora, Mexico ..... *Stuart F. Simmons and F. J. Sawkins* 521
Stretching of Fluid Inclusions Resulting from a Low-Temperature Microthermometric Techinque ..... *Jeanne P. Lawler and Maria L. Crawford* 527
A Note on a Fluid Inclusion Study of Tin-Tungsten Mineralization at Mawchi Mine, Kayah State, Burma ..... *U Khin Zaw and Daw Khin Myo Thet* 530
A Method of Calculating Fluid Inclusion Volumes Based on Vapor Bubble Diameters and P-V-T-X Properties of Inclusion Fluids ..... *R. J. Bodnar* 535

Discussion

Metallogeny of Tin: Magmatic Differentiation versus Geochemical Heritage—A Discussion ..... *P. J. Pollard, R. G. Taylor, and C. Cuff* 543

Reviews

Uranium in Volcanic and Volcaniclastic Rocks (Philip Goodell and Aaron Waters, eds.) ..... *Gail A. Mahood* 546
Mineral Deposits of Europe. Volume 2: Southeast Europe (F. W. Dunning, W. Mykura, and D. Slater, eds.) ..... *E. T. C. Sponner* 548
Drilling and Sampling Techniques in Tin Prospecting. Proceedings of a Seminar Held in Ipoh, Malaysia, 6–8 September 1979 (Abdullah Hasbi bin Haji Hassan and Hubertus van Wees, eds.) ..... *C. L. Sainsbury* 549
The Deep-Sea Drilling Project: A Decade of Progress (J. E. Warme, R. G. Douglas, and E. L. Winterer, eds.) ..... *William W. Hay* 549
Andesites: Orogenic Andesites and Related Rocks (R. S. Thorpe, ed.) ..... *Richard H. Sillitoe* 551
Books Received ..... *Brendan Caulfield, Paul Merewether, and Kevin Shelton* 552
Interesting Papers in Other Journals 553
Society of Economic Geologists 563
SEG Presidential Address: Our Evolving Society of Economic Geologists .... *Donald E. White* 566
Announcements 572
Erratum 572

Number 4

AN ISSUE DEVOTED TO TECHNIQUES AND RESULTS OF REMOTE SENSING

Remote Sensing for Exploration: An Overview ..... *Alexander F. H. Goetz, Barrett N. Rock, and Lawrence C. Rowan* 573

Remote Sensing for Porphyry Copper Deposits in Southern Arizona ..... *Michael J. Abrams, David Brown, Larry Lepley, and Ray Sadowski* 591
Remote Detection of Metal Anomalies on Pilot Mountain, Randolph County, North Carolina ..... *N. M. Milton, William Collins, Sheng-Huei Chang, and R. G. Schmidt* 605
Integrated Analysis of High-Resolution Field and Airborne Spectroradiometer Data for Alteration Mapping ..... *Stuart E. Marsh and John B. McKeon* 618
Mineral Exploration with Skylab Photography in Central Colorado ..... *Gary Prost* 633
Use of Airborne Multispectral Scanner Data to Map Alteration Related to Roll-Front Uranium Migration ..... *Douglas C. Peters* 641
Digital Image Processing Applied to Analysis of Geophysical and Geochemical Data for Southern Missouri ..... *E. A. Guinness, R. E. Arvidson, C. E. Leff, M. H. Edwards, and D. L. Bindschadler* 654
Mineralogical Characterization of Rock Surfaces Formed by Hydrothermal Alteration and Weathering—Application to Remote Sensing ..... *William F. Buckingham and Sheldon E. Sommer* 664
Use of Multispectral Scanner Images for Assessment of Hydrothermal Alteration in the Marysvale, Utah, Mining Area ..... *M. H. Podwysocki, D. B. Segal, and M. J. Abrams* 675
Mineral Discrimination Using a Portable Ratio-Determining Radiometer ..... *Gene Whitney, M. J. Abrams, and A. F. H. Goetz* 688
Application of Reflectance Spectrometry to Mineral Exploration Using Portable Radiometers ..... *D. R. Gladwell, R. E. Lett, and P. Lawrence* 699
Use of Landsat Multispectral Scanner Data for the Definition of Limonitic Exposures in Heavily Vegetated Areas ..... *Donald B. Segal* 711
Confirmation of the Airborne Biogeophysical Mineral Exploration Technique Using Laboratory Methods ..... *Sheng-Huei Chang and William Collins* 723
Airborne Biogeophysical Mapping of Hidden Mineral Deposits ..... *William Collins, Sheng-Huei Chang, Gary Raines, Frank Canney, and Roger Ashley* 737
The Application of Remote Sensing to Geobotanical Exploration for Metal Sulfides—Results from the 1980 Field Season at Mineral, Virginia ..... *M. L. Labovitz, E. J. Masuoka, R. Bell, A. W. Siegrist, and R. F. Nelson* 750
Use of Reflectance Spectra of Native Plant Species for Interpreting Airborne Multispectral Scanner Data in the East Tintic Mountains, Utah ..... *N. M. Milton* 761
Multitemporal Remote Sensing of a Geobotanical Anomaly ..... *J. P. Darch and J. Barber* 770

Reviews

Uranium 81 (P. R. Simpson, Jane A. Plant, and G. C. Brown, eds.) ..... *J. Thomas Nash* 783
Offshore Tidal Sands: Processes and Deposits (A. H. Stride, ed.) ..... *Larry F. Boyer* 783
Continental and Oceanic Rifts (G. Palmason, ed.) ..... *Ian D. MacGregor* 784
World Energy Supplies, Resources, Technologies, Perspectives (Manfred Grathwohl) ... *B. J. S.* 785
Computer Applications in Geology, I and II (M. F. Horder and R. J. Howarth, eds.) ..... *George S. Koch, Jr.* 785
Sulfur: New Sources and Uses (M. E. D. Raymont, ed.) ..... *Robert L. Bates* 786
Books Received ..... *Brendan Caulfield, Paul Merewether, and Kevin Shelton* 786
Interesting Papers in Other Journals 788
Society of Economic Geologists 796

Number 5

The Olympic Dam Copper-Uranium-Gold Deposit, Roxby Downs, South Australia ..... *D. E. Roberts and G. R. T. Hudson* 799
The Nabarlek Uranium Deposit, Northern Territory, Australia: Some Petrologic and Geochemical Constraints on Genesis ..... *G. R. Ewers, John Ferguson, and T. H. Donnelly* 823
Chronology of Magmatism, Skarn Formation, and Uranium Mineralization, Mary Kathleen, Queensland, Australia ..... *R. W. Page* 838
Sequence of Mineral Assemblages in Differentiated Granitic Pegmatites ..... *James J. Norton* 854

Geology of the Golden Grove Prospect, Western Australia: A Volcanogenic Massive Sulfide-Magnetite Deposit ..... *K. M. Frater* 875
The Dae Hwa Tungsten-Molybdenum Mine, Republic of Korea: A Geochemical Study ..... *Chil-Sup So, Kevin L. Shelton, David E. Seidemann, and Brian J. Skinner* 920
Geologic Setting and Origin of the Lucifer Manganese Deposit, Baja California Sur, Mexico ..... *Daniel A. Freiberg* 931
The Holden Mine, a Metamorphosed Volcanogenic Deposit in the Cascade Range of Washington ..... *John L. Nold* 944
Silicification: Hydrothermal Alteration in an Archean Geothermal System within the Amulet Rhyolite Formation, Noranda, Quebec ..... *H. L. Gibson, D. H. Watkinson, and C. D. A. Comba* 954
Volcanic Stratigraphy of the Pilot Knob Iron Deposits, Iron County, Missouri ..... *Samuel V. Panno and William C. Hood* 972
Thermal Constraints on the Formation of Mississippi Valley-Type Lead-Zinc Deposits and Their Implications for Episodic Basin Dewatering and Deposit Genesis ..... *L. M. Cathles and A. T. Smith* 983

Scientific Communications

K-Ar Age Data for the El Teniente Porphyry Copper Deposit, Central Chile ..... *Alan H. Clark, Edward Farrar, Francisco Camus, and G. Stewart Quirt* 1003
Distribution of the Lanthanides and Yttrium in Apatites from Iron Ores and Its Bearing on the Genesis of Ores of the Kiruna Type ..... *Michael Fleischer* 1007
Lead Isotope Study of a Lead-Zinc Vein Mineralization and Its Host Sediments, Heure, Belgium: Basis for a Genetic Model ..... *S. Cauet and D. Weis* 1011
Geophysical Constraints on the Size and Extent of the Wabana Hematite Deposit ..... *H. G. Miller* 1017
The Application of Cathodoluminescence in Relative Dating of Barite Mineralization in the Lower Magnesian Limestone (Upper Permian), United Kingdom ..... *Gill Harwood* 1022

Reviews

Mineral Deposits and Global Tectonic Settings (A. H. G. Mitchell and M. S. Garson) ..... *Peter A. Ronc* 1028
Geology of Canadian Gold Deposits. Proceedings of the CIM Gold Symposium, Val-d'Or, Quebec, September 1980 (R. W. Hodder and William Petruk, eds.) ..... *Arthur S. Radtke* 1028
Komatiites (N. T. Arndt and E. G. Nisbet, eds.) ..... *Sarah-Jane Barnes* 1029
Complex Tin Ores and Related Problems (Abdullah Hasbi bin Haji Hassan and Hubertus van Wees, eds.) ..... *Michael Solomon* 1030
Books Received ..... *Brendan Caulfield, Paul Merewether, and Kevin Shelton* 1030
Interesting Papers in Other Journals 1033
Announcements 1042

Number 6

Role of Fluid Mixing and Fault-Related Sulfide in the Origin of the Ray Point Uranium District, South Texas ..... *Martin B. Goldhaber, Richard L. Reynolds, and Robert O. Rye* 1043
Sheeted Vein Sn-W Mineralization and Greisenization Associated with Economic Kaolinization, Goonbarrow China Clay Pit, St. Austell, Cornwall, England: Geologic Relationships and Geochronology ..... *Colin J. Bray and Edward T. C. Spooner* 1064
Lead Isotope Systematics of Strata-Bound Sulfide Deposits in the Higher Nappe Complexes of the Swedish Caledonides ..... *Krister Sundblad and Michael B. Stephens* 1090
The Manganese Deposits of Griqualand West, South Africa: Some Mineralogic Aspects ..... *J. E. de Villiers* 1108
Geology and Ore Deposits of the Toqui District, Aysen, Chile ..... *F. W. Wellmer, E. J. Reeve, E. Wentzlau, and H. Westenberger* 1119

The Mattagami Lake Mine Archean Zn-Cu Sulfide Deposit, Quebec: Hydrothermal Coprecipitation of Talc and Sulfides in a Sea-Floor Brine Pool—Evidence from Geochemistry, $^{18}O/^{16}O$, and Mineral Chemistry ..... *U. R. Costa, R. L. Barnett, and R. Kerrich* 1144
A Fluid Inclusion Investigation of Ore Formation in a Tin-Mineralized Granite, New England, New South Wales ..... *P. J. Eadington* 1204
Petrochemical Studies of the Dunka Road Cu-Ni Deposit, Duluth Complex, Minnesota ..... *B. V. Rao and Edward M. Ripley* 1222
Geology of Oued Mekta, a Mississippi Valley-Type Deposit, Touissit-Bou Beker Region, Eastern Morocco ..... *Petr Rajlich* 1239
Strontium Isotopic Evidence for the Origin of Barites and Sulfides from the Mississippi Valley-Type Ore Deposits in Southeast Missouri ..... *S. Lange, S. Chaudhuri, and N. Clauer* 1255

Scientific Communications

Cryogenic Scanning Electron Microscopy of Fluid Inclusions in Ore and Gangue Minerals ..... *William C. Kelly and Paul A. Burgio* 1262
Definition of Mineral Resource Potential ..... *R. B. Taylor and T. A. Steven* 1268

Reviews

Lagerstättenlehre—Eine Einfuehrung in die Wissenschaft von den Mineralischen Bodenschaetzen, 3rd edition (Walther E. Petrascheck and Walter Pohl) ..... *Half Zantop* 1271
Pedology: Pedogenesis and Classification (P. Duchaufour. T. R. Paton, translator) ..... *David J. Vaughan* 1271
Climatic Geomorphology (Julius Büdel. Lenore Fischer, and Detlef Busche, translators) ..... *Arthur L. Bloom* 1272
Environmental Isotopes in the Hydrosphere (V. I. Feronsky and V. A. Polyakov. S. V. Ferronsky, translator) ..... *Kevin L. Shelton* 1272
Albuquerque Country II. New Mexico Geological Society, 33rd Annual Field Conference, November 4–6, 1982, Guidebook (J. A. Grambling and S. G. Wells, editors) ..... *Clay T. Smith* 1273
Books Received ..... *Brendan Caulfield, Paul Merewether, and Kevin Shelton* 1274
Interesting Papers in Other Journals 1278
Society of Economic Geologists 1285

Number 7

The J-M Platinum-Palladium Reef of the Stillwater Complex, Montana: II. Origin by Double-Diffusive Convective Magma Mixing and Implications for the Bushveld Complex ..... *T. N. Irvine, D. W. Keith, and S. G. Todd* 1287
Analysis of Gold in Surface Waters from Australian Goldfields: An Investigation into Direct Hydrogeochemical Prospecting for Gold .. *T. W. Hamilton, J. Ellis, T. M. Florence, and J. J. Fardy* 1335
Bar to Bank Flow Convergence Zones: A Contribution to the Origin of Alluvial Placers ..... *Norman D. Smith and N. J. Beukes* 1342
The Application of Illite Crystallinity, Organic Matter Reflectance, and Isotopic Techniques to Mineral Exploration: A Case Study in Southwestern Gaspé, Quebec ..... *Daria Duba and Anthony E. Williams-Jones* 1350
Geophysical Log Documentation of Fluid Migration from Compacting Shales: A Mineralization Model from the Devonian Strata of the Pine Point Area, Canada ..... *Nathaniel G. Smith, J. Richard Kyle, and Kinji Magara* 1364
$^{87}Sr/^{86}Sr$ Ratio Measurements on Sulfides, Carbonates, and Fluid Inclusions from Pine Point, Northwest Territories, Canada: An $^{87}Sr/^{86}Sr$ Ratio Increase Accompanying the Mineralizing Process ..... *G. A. Medford, R. J. Maxwell, and R. L. Armstrong* 1375
Supergene Processes in Zinc-Lead-Silver Sulfide Ores in Carbonates ..... *S. R. Sangameshwar and H. L. Barnes* 1379
Structural Evolution of the Sullivan Fe-Pb-Zn-Ag Orebody, Kimberley, British Columbia, Canada ..... *K. R. McClay* 1398

Fluid Inclusion Evidence for Fluid Mixing, Mascot-Jefferson City Zinc District, Tennessee ..... *Mark Taylor, Stephen E. Kesler, Paul L. Cloke, and William C. Kelly* 1425
The Geology and Geochemistry of the Zoned, Sn-W-F-Be Skarns at Mt. Lindsay, Tasmania, Australia ..... *Teunis A. P. Kwak* 1440
Lead Isotope Studies Bearing on the Genesis of Copper Orebodies at Mount Isa, Queensland ..... *Brian L. Gulson, William G. Perkins, and Karen J. Mizon* 1466
Geochemistry of Pyrite and Black Shales of Amjhore, Rohtas District, Bihar, India ..... *H. S. Pandalai, T. Majumder, and D. Chandra* 1505
A Petrographic Study of Phyllic Alteration Superimposed on Potassic Alteration: The Sibert Porphyry Deposit (Rhone, France) ..... *D. Beaufort and A. Meunier* 1514

Discussions
Adaptation of SGE-USGS Heating-Freezing Stage for Operation Down to −196°C—A Discussion ..... *Robert C. Smith* 1528
Adaptation of SGE-USGS Heating-Freezing Stage for Operation Down to −196°C—A Reply ..... *Jill Dill Pasteris* 1529

Reviews
Geochemical Exploration in Deeply Weathered Terrain (R. E. Smith, editor) ..... *A. A. Levinson* 1530
Precambrian Sulphide Deposits: The H. S. Robinson Memorial Volume (R. W. Hutchinson, C. D. Spence, and J. M. Franklin, editors) ..... *B. J. S.* 1530
Sandstone Depositional Environments (Peter A. Scholle and Darwin Spearing, editors) ..... *B. J. S.* 1531
Uranium Series Disequilibrium: Applications to Environmental Problems (M. Ivanovich and R. S. Harmon, editors) ..... *Terry F. Rees* 1531
Carbonate Buildups—A Core Workshop. Society of Economic Paleontologists and Mineralogists Core Workshop 4, Dallas, Texas, April 16–17, 1983 (Paul M. Harris, editor) ..... *Dimitri A. Sverjensky* 1532
Geology at M.I.T., 1865–1965. A History of the First Hundred Years of Geology at Massachusetts Institute of Technology. Vol. II. Departmental Operations and Products (Robert Rakes Shrock) ..... *B. J. S.* 1532
Books Received ..... *Brendan Caulfield, Paul Merewether, and Kevin Shelton* 1533
Interesting Papers in Other Journals 1535
Society of Economic Geologists 1544

Number 8

Carbon, Hydrogen, Oxygen, and Sulfur Isotope and Fluid Inclusion Study of the Weolag Tungsten-Molybdenum Deposit, Republic of Korea: Fluid Histories of Metamorphic and Ore-Forming Events ..... *Chil-Sup So, Danny M. Rye, and Kevin L. Shelton* 1551
The Mobility and Distribution of Heavy Metals during the Formation of First Cycle Red Beds ..... *R. A. Zielinski, S. Bloch, and T. R. Walker* 1574
Geologic and Fluid Controls on As-Sb-Au Mineralization in the Moretons Harbour Area, Newfoundland ..... *Alexandra Kay and D. F. Strong* 1590
A Correlation between the Evolution of Mineralizing Fluids and the Geomechanical Development of a Shear Zone as Illustrated by the Henderson 2 Mine, Quebec ..... *Jayanta Guha, Guy Archambault, and Jacques Leroy* 1605
Sulfur Isotope Study of the Aberfeldy Barite, Zinc, Lead Deposit and Minor Sulfide Mineralization in the Dalradian Metamorphic Terrain, Scotland ..... *Robert C. R. Willan and Max L. Coleman* 1619
Genesis and Evolution of the Marquesado and Adjacent Iron Ore Deposits, Granada, Spain ..... *J. Torres-Ruiz* 1657
Lead Isotope Composition of Caledonian Sulfide-Bearing Veins in Sweden ..... *Åke Johansson* 1674
The Genesis and Metamorphism of the Arinteiro-Bama Cu Deposits, Santiago de Compostela, Northwestern Spain ..... *Patrick J. Williams* 1689

Hydrothermal Alteration of Graywacke and Basalt by 4 Molal NaCl ..... *Robert J. Rosenbauer, James L. Bischoff, and Arthur S. Radtke* 1701

Scientific Communications

Sea-Floor Massive Sulfide Deposits from 21°N, East Pacific Rise; Juan de Fuca Ridge; and Galapagos Rift: Bulk Chemical Composition and Economic Implications ..... *James L. Bischoff, ... Robert J. Rosenbauer, Philip J. Aruscavage, Philip A. Baedecker, and James G. Crock* 1711

Low-Temperature Glass Quenched from a Synthetic, Rare Earth Carbonatite: Implications for the Origin of the Mountain Pass Deposit, California .... *Adrian P. Jones and Peter J. Wyllie* 1721

Reviews

Sulphide Minerals: Crystal Chemistry, Parageneses, and Systematics (Ivan Kostov and Jordanka Minceva-Stefanova) ..... *James R. Craig* 1724

Biological Methods of Prospecting for Minerals (R. R. Brooks) ..... *John R. Watterson* 1724

Books Received ..... *Brendan Caulfield, Paul Merewether, and Robert Tucker* 1724

Interesting Papers in Other Journals 1726

Society of Economic Geologists 1733

SEG Presidential Address: Hydrothermal Concepts: The Old and the New ... *R. W. Hutchinson* 1734

Reviewers of Books 1742

Index, Volume 78 1743

Contents, Volume 78 iii